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THE STRUCTURE OF THE INFERIOR MAXILLA WITH SPECIAL REFERENCE TO THE POSITION OF THE INFERIOR DENTAL CANAL.

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So far as I know, no complete account exists of the Structure of the Inferior Maxilla, nor is anything beyond a somewhat broad reference made to the position of the Inferior Dental Canal in that bone. The object of this paper is to make up this deficiency, and the statements made in it are based upon observations made on sections of a great number of bones. There are so many varieties of construction of the lower jaw that it is difficult to fix on any one as being typical. Many that I examined in the macerated condition were practically devoid of cancellous tissue in the interior, and the inferior dental canal had disappeared, the bone being a mere shell; others, again, were practically solid, so that the terms "pneumatic" and "diploëtic" might almost be applied, as in similar conditions of the mastoid process: fortunately, however, a good many jaws show both cancellous and compact tissue, and with such I propose to deal in this paper, choosing to regard them as typical. My conclusions are based on serial *coronal* sections of the jaw made from the symphysis menti to the neck, and *horizontal* sections through the neck and condyle.

Method of procedure.—The jaw was first divided mesially, and one-half was laid flat on a table against a block of wood with a transverse slot in it, wide enough to admit a fine tenon-saw, much after the fashion of a mitre block used in making picture-frames. With this aid I was enabled to cut perfectly straight sections. As far as possible the sections were made equal in thickness, though the thickness depended to a certain extent on the size of the tooth alveoli. The saw was carried through the middle of the alveoli and through the septum between adjacent alveoli. The sections through the coronoid process and ramus were as far as possible equal in thickness to those of the body.

General Appearances.—It will be found convenient to study the general appearances of sections taken at four different points, and I shall in the first place describe a section through the *body*

of the jaw,—it matters little at what point, so long as it is behind the mental foramen. If the section be taken through an alveolus (figs. 7 to 13) it will be seen to consist of a shell of compact bony tissue, somewhat U-shaped, with the vertical limbs of the U connected by a thin bridge of compact tissue, depressed in the middle to form an alveolus. The lateral and inferior walls are much thicker than the superior, which contains the alveolus.

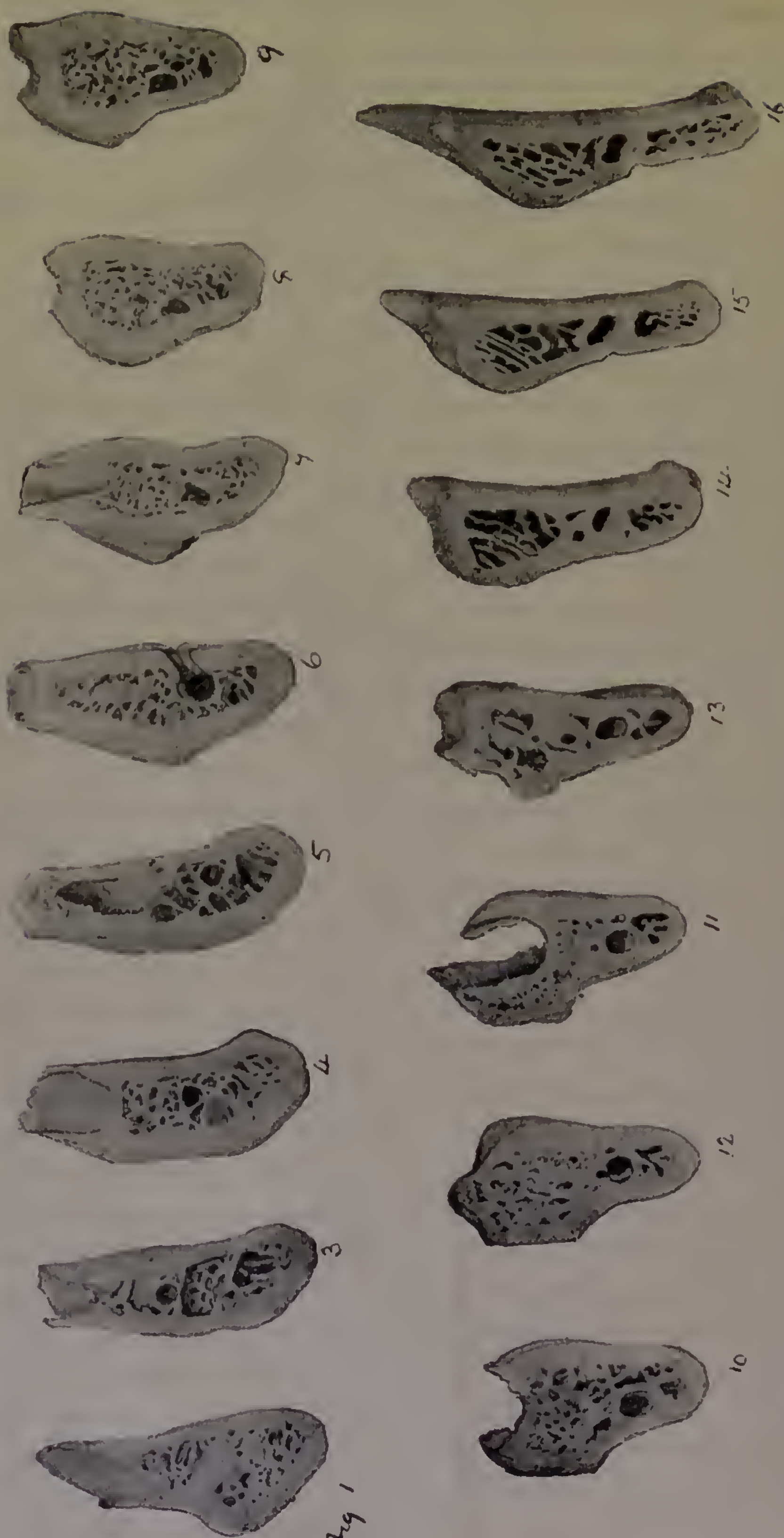
This shell of compact bone is marked, as is well known, by various ridges or lines, grooves, and fossæ, by structures attached to it or in close contact with it. Most of these have little bearing on the question under consideration; and with the exception of the internal oblique line, and the groove for the mylo-hyoid nerve and vessels, I shall ignore them.

The outer wall of compact tissue, as seen in our section, is for all practical purposes flat or slightly concave, whereas the inner wall differs markedly from it in being concavo-convex, the convexity in the upper half being caused by the internal oblique line or mylo-hyoid ridge, the concavity below being partly the result of that projection and partly due to the submaxillary gland. In this hollow the groove for the mylo-hyoid vessels and nerve can be traced in well-marked bones as far as a point opposite the second molar tooth. This groove is of considerable importance, inasmuch as it indicates with tolerable accuracy the downward course taken by the posterior half of the inferior dental canal. The shell of compact bone encloses a network of cancellous tissue and the inferior dental canal. The cancellous tissue consists of trabeculæ which, springing from the shell of compact tissue, interlace with one another in an irregular fashion, to form a network whose meshes are for the most part irregular, and generally very small. Embedded in this cancellous tissue, at about the junction of the upper two-thirds with the lower third of the bone, and for the greatest part of its extent, lying against the inner wall, is the inferior dental canal, which may be distinguished from the surrounding meshes by its greater calibre and regularity of walls, which are formed by a thin layer of compact tissue. We may also see the socket for a tooth reaching a considerable way down, and contracting to a point as it terminates, which it does a very little way above the inferior dental canal. From the wall of the socket trabeculæ project on all sides—in fact, the wall of the socket

may be regarded as consisting of the fused ends of numerous trabeculæ. Each socket is perforated at its apex or point for the vessels and nerve to the tooth contained, and in its wall near the base innumerable small foramina can be seen, connected in the recent condition with the periodontal membrane.

Such are the general appearances presented by a section through the body of the jaw.

Sections through special regions of the jaw.—Now let us examine a section through the *coronoid process and ramus* (figs. 18, 19, 20). The appearances of such a section vary with the site at which it is taken. If *anterior* to a line connecting the tip of the coronoid process with the angle of the jaw, the section will be modified by the inferior dental canal and the temporal muscle; if *posterior* to that line the inferior dental canal will be absent, though the inner wall will show the groove leading to that canal, and we may or may not cut through the area occupied by the tendon of the temporal muscle; if the section be behind the temporal area the coronoid process is practically solid, differing in this respect from the part occupied by the temporal muscle. A section made through the line mentioned above will cut through the base of the lingula, and either just catch the beginning of the inferior dental canal or run through the groove leading to it. In most of my own sections the groove is cut through immediately behind the canal, and on this understanding I shall describe the appearances presented by such a section which is practically like that numbered 18 in the plate. It shows a shell of compact bone somewhat thinner than that of the body, and different in shape also, of course. There is no upper (alveolar) thin wall of compact tissue, the outer and inner walls running together to a point above; no tooth socket is seen; in other respects the compact tissue of this segment is like that taken from the body of the jaw. The cancellous tissue, here above the level of the inferior dental canal, differs markedly in arrangement from that of the corresponding area in the body of the jaw. The trabeculæ no longer form an irregular network enclosing somewhat circular meshes, but they are arranged for the most part in parallel rows which, springing from the inner wall of the coronoid process and the roof of the inferior dental groove, pass upwards nearly parallel with the inner wall, though deviating a little from



Sections 1–5 are anterior to mental foramen. Section 6 is through mental canal. Sections 7–13 are posterior to mental foramen and anterior to ramus and coronoid process. Sections 14–23 are through ramus and coronoid process. Sections 24–26 are through neck. Sections 27, 28 are through condyle.


17
18
19
20
21
22
23
24
25
26 (from nature)
27
Lini groove

it on their way, so that they end on the outer wall, forming with it a very acute angle. These trabeculæ are laminar in form, with their surfaces directed laterally, and they are connected together at short intervals by short and much weaker thread-like trabeculæ placed at right angles to them, so that the long interlaminar spaces are broken up into rectangular, oblong, or elliptical short spaces. The cancellous tissue occupying the area below the dental groove resembles that of the body of the jaw in being composed of an irregular network of trabeculæ, though it also, near the lower wall, may show an attempt at parallelism of trabeculæ with much the same direction as those of the area above the groove.

This parallel arrangement of fibres is certainly due to the traction exerted by the temporal and masseter muscles.

It is well known to all anatomists that the direction of the trabeculæ of cancellous tissue is largely dependent on two forces, viz., pressure (and the opposite of pressure—traction) and tension; and here we have an excellent example of trabeculæ arranged by traction of two muscles, viz., the temporal and the masseter. The trabeculæ are parallel to neither tendon, but to the resultant of contraction of the two.

I have said that slight parallelism of trabeculæ may be seen in the lower area: this is produced by traction of the internal pterygoid and masseter muscles.

There can be no doubt about traction being the cause here; for if we make sections anterior to the attachment of the temporal muscle, the cancellous tissue in the upper area becomes irregular, and shows not the slightest attempt at parallelism of trabeculæ. Further examples will be met with as we pass on.

Let us now examine the structure of the *neck* of the jaw. This is best done by making a horizontal section through the neck just below the condyle, cutting through the fossa for insertion of the external pterygoid muscle. Such a section is somewhat triangular, with the apex inwards. The shell of compact bone is much thinner than in the other sections, and the enclosed cancellous tissue in the form of a very small-meshed network, the main trabeculæ of which run forwards and somewhat outwards, and are more or less parallel to one another. In many sections these trabeculæ run quite sagittally (figs. 24, 25, 26).

In the *condyle* (figs. 27, 28) the compact tissue is still thinner where it forms the articular surface, and the cancellous tissue, when looked at in horizontal section, forms a close, small-meshed network, but when seen in coronal section, shows the main trabeculæ running vertically upwards and parallel with one another: here evidently pressure has to be resisted more than traction.

The Inferior Dental Canal.—We may now turn our attention to the inferior dental canal and trace it from beginning to end. This canal commences in the ramus of the jaw, midway between its anterior and posterior borders, and at the point of junction of the lower one-third with the upper two-thirds of a line drawn between the tip of the coronoid process and the angle of the jaw, and on a level with the upper surfaces of the molar teeth (*Quain*), by a funnel-shaped aperture; but for some little distance behind the real commencement of the canal a groove exists on the inner wall of the ramus which, caused by the inferior dental nerve and vessels, runs downwards and forwards into the canal; and the entrance to the canal is often concealed by that free end of the splenial called the lingula, to which the so-called internal lateral ligament of the jaw is attached.

A section made through the beginning of the canal shows it to be pyriform, with the large end downwards and slightly outwards, the small end upwards and inwards, and in its long axis being about 7 mm., its width being 3 mm. Three millimetres in front of this point the long diameter has fallen to 3½ mm., the transverse to 2½ mm., and the canal here is seen to be half embedded in the inner wall of the jaw, and more so at its upper end than at its lower, on account of the obliquity of its long axis. The outer wall of the canal consists of a thin shell of compact tissue connected by trabeculæ with the outer wall of the jaw. The direction of the canal at this point is forwards, downwards, and slightly outwards (fig. 18).

In the segment of the coronoid process and ramus (fig. 17), immediately anterior to the last, and 4 mm. in thickness, the canal travels outwards, so that its outer wall blends with the outer wall of the jaw, and whilst its inner wall is blended with the inner wall of the jaw; the latter is not grooved by the canal as it was in the previous segment, and as it is indeed at the back

of the present segment. The canal still is directed forwards, downwards—markedly—and slightly outwards, and it lies at about the junction of the upper two-thirds with the lower third of the segment.

The next segment, taken immediately anterior to the last, and, like it, of the coronoid process and ramus, and 4 mm. thick (fig. 16), shows the canal still tending outwards, so that it has at its anterior end slightly grooved the outer wall of the jaw, but its inner wall is still blended with the inner wall of the jaw. The lumen is somewhat bluntly pyriform in shape, with the small end directed upwards and inwards, and the general direction of the canal is downwards, forwards, and outwards.

In the next segment of the coronoid process and ramus the canal still grooves the outer wall of the jaw and reaches the inner wall, is now oval in section—it may be divided almost into two here by a septum of bone; its long axis is oblique, the upper end being directed inwards, the lower outwards. The upper and lower walls are very thick. This segment is 3 mm. in thickness.

The next segment, also 3 mm. in thickness, includes the root of the coronoid process just behind the last molar tooth (fig. 14). The lumen of the canal is now almost circular. The canal itself still grooves the outer wall; is directed downwards, forwards, and a little outwards. Both its upper and lower walls are thick.

The next segment (fig. 13), 4 mm. thick, included the posterior part of the obliterated socket of the last molar tooth. In this the lumen of the canal is oval, with the long diameter now vertical, and the canal, though lying nearer the outer wall of the jaw, no longer grooves it, and is directed at its anterior end forwards and a little downwards, with no inclination outwards. The upper and lower walls are somewhat thinner than in previous segments.

The next segment, 3 mm. in thickness, includes the middle of the obliterated socket of the last molar tooth (fig. 12).

Here the lumen of the anterior end of the canal is almost circular and lies *midway* between the outer and inner walls of the jaw, and the canal is now looking forwards, downwards, and slightly inwards at its anterior end. Its lower wall is now within 7 mm. of the lower border of the jaw.

The next segment (fig. 11) includes the posterior half or so of the socket for the second molar tooth. The anterior lumen of the canal, still nearly circular in form, is seen against the *inner* wall of the jaw; the outer wall of the canal is now quite separate from the outer wall of the jaw, though connected with it by trabeculæ, and the canal is now directed forwards, with very slight inclinations downwards and inwards. Its lower wall is now 6 mm. from the lower border of the jaw.

The next segment includes the anterior part of the socket for the second molar, and is 4 mm. thick (fig. 10). The canal is again oval, with long diameter vertical; it slightly grooves the inner wall of the jaw; its outer wall is very thin, and separated by an interval of 2 mm. from the outer wall of the jaw. Its direction is forward, slightly inwards, and very slightly downwards. Its lower wall is 5 mm. from the lower border of the jaw.

The next segment includes the posterior half of the obliterated socket of the first molar tooth, and is 4 mm. thick (fig. 9). The canal, vertically oval, grooves the inner wall; its very thin outer wall is 2 mm. from the outer wall of the jaw, its direction is *absolutely forwards*. The lower wall is 7 mm. from the lower wall of the jaw.

The next segment includes the middle of the obliterated socket of the first molar tooth. The canal, still vertically oval, has a very thin outer wall, separated by an interval of nearly 3 mm. from the outer wall of the jaw. Its direction is now at its anterior end forwards and very slightly *outwards*. The distance of its lower wall from that of the jaw is 7 mm.

The next segment (fig. 8) includes the anterior half of the obliterated socket of the first molar. It shows the canal, vertically oval, now separated at its anterior end, very slightly separated from the inner wall of the jaw by cancellous tissue, and 2 mm. from the outer wall of the jaw. It is directed forwards, outwards, and very slightly *upwards*. Its lower wall is 8 mm. from the lower wall of the jaw.

The next segment (fig. 7) includes the posterior half of the socket for the second bicuspid tooth. The canal, once more circular in lumen, has very thin walls, which are free, the inner 1 mm. from the inner wall of the jaw, the outer $1\frac{1}{2}$ mm. from the outer wall of the jaw. Its direction is forwards,

slightly upwards, and markedly outwards. Its lower wall nearly 9 mm. from the lower border of the jaw.

The next segment, 4 mm. in thickness (fig. 6), includes the anterior half of the socket for the second bicuspid, and the posterior two-thirds of the canal for the mental nerve and vessels. The dental canal may be said to terminate here, by bifurcating into "mental" and "incisive" canals; and at the point of bifurcation, which takes place some little distance behind the point where the mental canal pierces the outer wall of the jaw, the canal lies against the *outer* wall of the jaw, is circular in lumen, and is 2 mm. from the inner wall of the jaw.

The "mental canal" runs at first forwards, outwards, and upwards, say in its first third upwards and outwards, in its middle third and backwards upwards, and outwards in its last third, ending at the mental foramen, in the adult jaw vertically below the ridge separating the second from the first bicuspid tooth, though this depends on race, and midway between the alveolar and lower borders of the jaw, this depending on age and the presence of teeth. The whole canal is about 5 mm. in length.

This segment shows very beautifully the exterior of the socket of the second bicuspid tooth and the trabeculæ in connection with it, and on looking into the cavity of the socket a considerable foramen can be seen at its apex which leads to the dental canal.

In the next segment (fig. 5), which includes a little of the anterior part of the mental canal and a good part of the socket for the first bicuspid, we have to deal with the "incisive" canal. This in the posterior part of the segment lies against the outer wall of the jaw, but after a course of 4 mm. is separated from that wall by a small amount, say 1 mm. in thickness, of cancellous tissue. Its direction is therefore forwards and inwards. The lumen is circular, much less in size than that of the dental canal, and the walls are very thin.

The next segment (fig. 4) includes the posterior part of the socket for the canine tooth. Here the "incisive" canal, $1\frac{1}{2}$ mm. in calibre, lies almost midway between the outer and inner walls of the jaw, and has very thin walls. The anterior lumen is circular, and the canal is directed forwards, slightly inwards, and upwards.

The next segment (fig. 3) includes the apex of the socket of the canine tooth, as well as a little of the upper posterior part

of that of the lateral incisor. This segment is 4 mm. thick. The incisive canal in the anterior half of this segment bifurcates, or, in other words, is divided into two parts, by a vertical septum: both resulting canals are very narrow, and lie midway between the anterior (outer) and posterior (inner) walls.

The next segment includes the greater part of the socket of the lateral incisor and the lower and posterior half of that of the medial. Here no trace of an incisive canal can be distinguished from the lumina of the cancellous tissue. The cancellous tissue here is very loosely arranged, though the main trabeculæ run downwards and backwards from the anterior wall to the posterior wall of the jaw; this direction being evidently due to traction exerted by the hyoid muscles and the anterior belly of the digastric.

The last segment (fig. 1) includes the greater part of the socket for the medial incisor and the left genial tubercles. It is interesting because it shows a strong bar of bone passing horizontally forwards from the upper genial tubercle to very near the anterior wall, which it ultimately reaches, having, however, previously broken up into a bunch of thick trabeculæ.

Let us now sum up the various facts yielded in the course of our examination of the position and course of the inferior dental canal and of its continuation, the "incisive" canal. We have seen that for the first 6 mm. of its course in the ramus of the jaw it lay in the inner wall of the jaw, and was separated from the outer by a small amount of cancellous tissue; in the next 8 mm. of its course, that it was midway between the two walls; in the next 8 mm. it was nearer the outer wall than the inner—in fact, grooved the outer wall; in the next 4 mm., that is, when under the first molar tooth, it lay midway between the two walls; that beyond that, to the level of the second bicuspid tooth, it lay against the inner wall of the jaw; and that from that point it inclined rapidly outwards, and in a course of some 4 mm. it gained the outer wall to and by bifurcating into mental and incisive canals; that the incisive canal, after a course of something like 6 mm., reached a point midway between the two walls of the jaw, and was finally lost sight of 4 mm. anterior to this, just below the apex of the socket of the canine tooth, or below the outer edge of the lateral incisor tooth. We have seen that the canal descended till it lay under the socket of the first molar tooth at its

posterior part, and that when under the anterior part of the socket of the first molar, or the septum between that and the socket of the second bicuspid, it began to rise, and continued to do so till it ended by bifurcating under the septum, between the second and first bicuspids. From what we have seen, then, it is evident that the position and course of the inferior dental canal are not quite so simple as the text-books would have us suppose. The figures I have quoted cannot, of course, be accepted as absolute, as probably no two jaws agree in dimensions, but they serve a useful purpose here, in delimiting the canal and its surroundings, and for that purpose alone have I submitted them. They are simply representative of the particular specimen I have described. The general course of the canal, its situation at various points of the bone, as stated here, may be taken as representative of the normal course and situation of the canal, as they agree with what I have seen in observations made on a considerable number of bones, and extended over a long period.

It may be thought that these results concerning the inferior dental canal might have been more easily obtained, and perhaps more accurately, by making longitudinal horizontal sections of the jaw, and by removing the outer wall; but though these methods are useful, they, I think, can only be considered as adjuncts to the method I have adopted, and may be used to verify results so obtained; and as the two latter methods fully confirm the statements I have made under the first method, there is no need for me to enter into further description of them, or the results obtained by their use, though I might perhaps say that in many specimens which have been cut horizontally along the internal oblique line, well-marked trabeculæ can be seen starting out from that line to act as tie-beams between it and the outer wall of the jaw: evidently these result from traction exerted by the mylo-hyoid muscle.

Lastly, let me incidentally mention the relationship of the occupants of the inferior dental canal, as though, perhaps, it is well known, yet in no text-book that I am familiar with is it alluded to. The chief occupants are, of course, the inferior dental nerve and artery. At the entrance into the canal, the artery lies behind the nerve; beyond that point, and so long as the canal descends, the artery usually lies below and behind the nerve; subsequently the artery in nearly all cases lies on the outer side of the nerve. These remarks, of course, relate to the unmacerated jaw.